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Biological Effects of Radiofrequency Energy

Some of you might plead the excuse of your ignorance, of a limited mind and a limited range. But the damned and the guiltiest among you are the men who had the capacity to know, yet chose to blank out reality, the men who were willing to sell their intelligence into cynical servitude to force: the contemptible breed of those mystics of science who profess a devotion to some sort of 'pure knowledge"— the purity consisting of their claim that such knowledge has no practical purpose on this earth—who reserve their logic for inanimate matter, but believe that the subject of dealing with men requires and deserves no rationality, who scorn money and sell their souls in exchange for a laboratory supplied by loot. And since there is no such thing as "non-practical knowledge" or any sort of "disinterested" action, since they scorn the use of their science for the purpose and profit of life, they deliver their science to the service of death . . . They, the intellects who seek escape from moral values, they are the damned on this earth, theirs is the guilt beyond forgiveness.

—A. Rand
Atlas Shrugged

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The earliest safety standards were based on energy absorption and temperature increases within tissue.[80] The two are mentioned together because it is a natural consequence of energy absorption that there will be a temperature increase in tissue. But subsequent revisions of the standards shifted attention to consideration of behavioral effects only. The shift away from internal biological effects became even more pronounced when the guideline for determining biological effects was changed to only "observable" effects. In other words, if an exposure doesn't result in an observable reaction or malfunction of the test subject, then the exposure isn't deemed to cause a biological effect. But what of the nonobservable effects or long—term consequences? Let's review some of the research results to determine the effects not included in determinations of safe radiation exposure levels. In a restatement of absorption characteristics, which by now must seem somewhat elementary, researchers again concluded in 1984 that to achieve deeper penetration of radiofrequency energy the 750-900 MHz range is better than 2450 MHz.[81] Particularly, it is known that radiofrequency energy absorption causes deep heating in tissue, which can lead to molecular damage, cell damage, or cell death. Any discussion of radiation exposure standards points out a serious bias that has been used effectively by opponents to stricter exposure limits. Safety standards are almost exclusively based on behavioral studies

[80] *H. P. Schwan, "Nonionizing Radiation H,azards," Journal of the Franklin Institute, December 1973, pp. 485-97.*

[81] *E. Friedenthal, et al., "Hyperthermia in the Treatment of Local Recurrence of Breast Cancer," Microwave Journal, May 1984, pp. 275-82.*

of laboratory animals. Usually laboratory animals are the test subjects and are trained to perform specific tasks such as running a maze or pressing a lever for food pellets. In order to assess the effects of radiofrequency radiation exposure, trained laboratory animals are observed while being irradiated with the energy. With testing repeated at various radiation levels the researchers can determine at which exposure levels the animals begin to lose the ability to perform the trained task. That's the process.

The very same safety standard that determines safe exposure of humans to radiofrequency radiation is based on whether or not it causes a rat to take more time to run a maze or causes a duck to peck for food pellets at a slower rate.

This then brings us to consider the fundamental flaw of the entire issue. Portable cellular telephones expose users to radiofrequency radiation and energy absorption in excess of the safety limits published by the Institute of Electrical and Electronic Engineers and adopted by the American National Standards Institute. These levels have been shown to cause behavioral effects and biological damage in laboratory animals.

In addition to simple behavioral effects there are nonbehavioral effects to be considered. Is the safety of the entire portable telephone—using population to depend on whether or not laboratory rats suffer memory deficits significant enough to cause the rat to forget how to run in maze? Does this also mean that the cellular telephone industry is prepared for the human user to suffer equivalent memory degradations and loss of capabilities?

In the past scientists were less certain of the danger threshold than they are today, but they were, nonetheless, greatly concerned that exceeding the threshold would lead to irreversible biological damage and harm.

Even exposures at levels generally thought to be non-damaging result in temperature rises of some tenths of a degree Celsius within the brain of humans. And that's without enhancements or consideration of "hot spot" formation. Nonuniform electrical properties of tissue result in nonuniform absorption and heating. Such nonuniform absorption and heating can lead to areas of damage and destruction within the head and brain even when the "average" exposure would seem to be not excessive.

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During 1948 researchers reported that electromagnetic radiation at 2,450 MHz "is highly productive in producing lenticular opacities.[82] The lenticular opacities of which the researchers were speaking are more commonly referred to as cataracts. During the experimental portion of the research it was found that exposure of the eye (in this case rabbit eyes) to radiofrequency radiation sufficient to raise the temperature in the eye to 46°C resulted in cataract formation from six to twenty-four days after exposure.

The researchers comment that in addition to the introduction of cataracts in eyes exposed to radiofrequency radiation, "microwave generators serve adequately for producing temperature increases in selected areas of the body." These same researchers reported that exposures (if rabbits' eyes at lower power density also leads to creation of cataracts.

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[82] *A. W. Richardson, T. D. Duane, and H. M. Hines, "Experimental lienticular Opacities Produced by Microwave Irradiations," Archives of Physical Medicine, December 1948, pp. 765-69.*

In another independent study, researchers found that radiofrequency radiation exposure could result in permanent eye damage at temperatures much lower than that reported by the Richardson team. This group reported that exposure of dog eyes to microwave energy sufficient to induce a temperature rise of from 1.9 to 3.2°C also produces cataracts. Tissue necrosis (death) and disorganization of the pigment layer were also observed under microscopic examination.83

Another report, by a Johns Hopkins researcher, Henry A. Kues, also contradicts the industry position. In the Kues report morphological changes, cell destruction, and cell death comparable to that which would be expected from ultraviolet radiation are reported for exposure of rhesus monkeys to 1,250, 2,450, and 2,850 MHz radiofrequency radiation. The researchers made a point of advising that the exposure levels were too low to produce any heating in the tissue84. These results are consistent with the findings of others that identify cell and DNA damage at low exposure levels. Because of this low level radiation damage these researchers have proposed that SAR may not always be an appropriate indicator of biological effects.

The 1980 research by L. S. Taylor indicates that radiofrequency energy exposure may inactivate enzymes or proteins that are involved in the repair process to correct DNA breaks. Thus, he indicated that, in addition to the prospect of causing direct DNA damage, radiofrequency

83 L. Daily, et al., "Effects of Microwave Diathermy on the Eye,"Society Proceedings, December 1948, p. 432.
84 H. A. Kues, "The Importance of Specific Microwave Parameters for the Induction of Ocular Effects in the Non-Human Primate," 16th Annual Bioelectromagnetics Society Meeting, June 12-17, 1994, abstract book, p. 7.

energy exposure may be responsible for inhibiting inherent DNA repair processes.[85]

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Early reports of a long-term study using laboratory rats to detect radiofrequency radiation-induced cancers became known during 1984. At the annual Bioelectromagnetic Society conference two researchers from a team at the University of Washington headed by Guy made presentations of their research that indicated an excess of malignant tumors in laboratory rats. Dr. Chang, of the National Institute of Occupational Safety and Health, and Dr. Milham, of the Washington State Department of Social and Health Services, "immediately deduced a pattern of increased malignancies in the endocrine system."[86] On the basis of the scientific presentations, conference meetings, and discussions with the researchers, Microwave News reported that,

microwaves can promote cancer, according to the first long-term study of microwave exposure ever carried out in the United States.

The research was sponsored by the U.S. Air Force and they forwarded the experimental findings to Dr. Vernal. Of the Toxic Hazards Research Unit at the University of (California at Irvine. According to Microwave News, Dr. Vcmot responded that the "finding of excess malignancies in the exposed animals is provocative."[86] The

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[85] *L. S. Taylor, "Implantable Radiators for Cancer Therapy by Microwave Hyperthermia," Proceedings of the IEEE 68, no. 1, (January 1980):142-49.*
[86] *Microwave News 4, no. 6, (July/August 1984):1.*

research findings were not published but instead became available as a series of air force reports that were not widely distributed.

The radiofrequency energy/cancer link debate heated up even further the following year, 1985, when Szmigielski reported an epidemiological study performed with Polish military personnel. The data indicate an increased incidence of cancer by as much as 6.7 times. Szmigielski stated that

I am very surprised with the results we obtained. There is an urgent need to repeat this study using another well-defined and well-controlled population.87

Not surprising is the fact that funding for replication studies has never been provided. However, that is no more surprising than the lack of funding for follow-up of the study that reported the significant increase of malignant tumors found in laboratory animals exposed to low-level radiofrequency radiation.

Recall that the U.S. Air Force sponsored the original study and that researchers have been clamoring for replication ever since the initial findings were made known. Since the original data was released three additional malignancies have been discovered which raises the total to eighteen for exposed rats versus five for controls. But, the research study has never been replicated.

As guest editor of the March 1987 edition of the IEEE Engineering in Medicine and Biology Magazine Gandhi wrote:

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87 "Polish Epidemiological Study Links RF/MW Exposures to Cancer," Microwave News 5, no. 2 (March 1985).

The coupling of electromagnetic radiation to the human body is quite complex, as it depends on frequency, polarization, far-field versus near-field, corporeal posture, etc. Funding for research in this area has generally been limited, which causes most of the studies to focus on acute short-term exposure levels. These studies are not relevant to an analysis of chronic low-level exposures lasting several years. Although an expanded research effort is needed, we are instead witnessing a rapid reduction in research efforts due to cutbacks in funding.

At that time the studies showing increased malignancies in laboratory animals and the data that found increased glial nodules as a result of low-level radiofrequency radiation exposure were well—known. The radiofrequency radiation exposures used for those studies were much lower than operators of today's portable cellular telephones experience.

Although never officially confirmed, there are reports in the scientific community—among the researchers-that the air force did replicate the low-level exposure studies first performed at the University of Washington. The unconfirmed reports are that the results were identical to what the university researchers found, that is, a dramatic increase in malignant disease due to low-level radiofrequency radiation exposure. If the reports of the secret research are true, it only confirms the findings of Guy and his team.

If the secret replication studies were never performed, it leaves the obvious question—how and why could such significant findings be cast inside by the government without replication studies?

In a 1985 survey of the literature, researchers R. S. Lin, et al., reported that a "greater—than-expected" incidence of gliomas and astrocytomas is related to occupations connected with exposure to radiofrequency electromagnetic fields. They also report that animal studies have shown proliferation of microglia in the brain following exposure to radiofrequency electromagnetic fields. The presence of microglia is a strong indicator of earlier tissue damage and a subsequent repair process. The cited study, that by Y. A. Kholodov (1966), predates the experiments Guy performed that yielded the glial nodules in the brains of his test subjects.88

Some researchers funded by industry or the military, faced with the prospect of releasing undesirable experimental findings, will employ a broad range of "devices" to put a favorable "spin" on the results and change the perspective of those findings. In a restatement of the effects to rats chronically exposed to low—level radiofrequency radiation some researchers seem to refute their own findings of a statistically significant increase of tumors in laboratory animals exposed to low-level electromagnetic energy. The report is an attempt to claim an effect in the unexposed control group by using the experimental group as a basis.

In that article the researchers describe the long-term U.S. Air Force—sponsored study performed by A. W. Guy, et al., over a three-year period.

It compared 100 rats that were irradiated for most of their lives with 100 rats that were not exposed to

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88 R.S. Lin, et al., "Occupational Exposure to Electromagnetic Fields and the Occurance of Brain Tumors," Journal of Occupational Medicine 27, no. 6 (June 1985):413-19.

radiation but were otherwise treated identically 89

Thus Guy has described the environment: 100 control group rats and 100 radiation exposed rats, all of which lived in identical environments.

After the experiments were completed, the researchers reported that eighteen malignant tumors developed in the exposed rats as compared to five in the control group rats. Such a difference the researchers claim is "statistically highly significant." They also state that

at face value this last finding suggests that low levels of microwave radiation can cause cancer in mice (and by inference to humans) . . . (see footnote 89).

The initial research findings were made known substantially as stated earlier. However, sometime later the researchers "reconsidered" their results and reversed their opinions.

The "politically correct" position is restated in the *Scientific American* article as:

For one thing, the total number of malignant tumors in the control animals was lower than the number expected for the particular strain of rat; the rate of malignancies in the exposed rats was about as expected . . . (see footnote 89).

Now let's review this data. All of the laboratory rats lived their lives in the same environment. Would we not expected that the entire group of 200 rats exhibit some similar level of tumor formation but not necessarily the same

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89 *K. R. Foster, and A. W. & Guy, "The Microwave Problem," Scientific American 255, no. 3 (September 1986):32-39.*

as that of the worldwide universe of rats? Would we not expect the level of tumor formation to be the same between two groups, say 100 rats in each group? And would we not also expect the ratio of tumor formation between one of those groups and the outside universe to be the same as for the other group and the outside universe?

That is not to say that the rate of tumor formation for the two groups of 100 rats will be the same as the rest of the universal population of the same type of rats. It simply means that the two groups of laboratory rats should show the same rate of tumor formation independent of the outside world.

Laboratory practice, health care, feeding, and other environmental factors will determine whether or not any isolated group of laboratory rats will develop malignant tumors at a rate identical with, exceeding, or, as in this case, less than the average for the overall rat population. That is exactly the purpose of maintaining a control group for such experiments.

With a control group to which the exposed group can be compared, only the experimental variable need be considered as providing the stimulus for any significant research results. These researchers found extraordinary results. They found entirely unexpected results. They found results that the business community, in concert with the U.S. military, could not accept. The researchers initially published those research findings as what the findings represented: evidence of cancer formation in rats that had been exposed to low-level radiofrequency radiation. Interestingly, since the initial findings were published and since the time of the restatement of those? findings, the principal researcher of that team has received very little research funding from the sources that had funded him generously earlier.

S. S. Stuchly has reported that .

> ***high SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous.***[90]

while M. A. Stuchly provided interesting insight into the thinking of some researchers with her review of Canadian protection guides. With respect to "hot spots" and near-zone exposures she wrote:

> ***One of the most important findings is that the SAR distributions are highly nonuniform, with typical ratios between spatial peak and whole-body average SA Rs of the order of 150:1 to 200:1. Even cursory consideration of physiology would suggest that high SARs in such tissues as brain or other vital organs are likely to be more critical in producing biological effects which may be potentially hazardous.***[91]

In her review she also noted the U.S. EPA stated that "the data currently available on the relationship of SAR to biological effects show evidence for biological effects at in SAR of about 1 W/kg." That is 1mW/g.

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[90] *S. Stuchly, et al., "Energy Deposition in a Model of Man: Frequency Effects," IEEE Transactions on Biomedical Engineering BME-33 7 (July 1986)702—11.*

[91] *M. A. Stuchly, Canadian and Other National RF Protection Guides, Electromagnetic Interaction with Biological Systems, ed. J. C. Lin (New York; Plenum, 1989) PP. 257-70.*

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In 1990, S. F. Cleary[92] provided one of the first advances in the study of cell-level bioeffects with a research report that indicates glial tissue, such as that which is found in the supporting structure of the brain, may be induced to increase in proliferation rate due to exposure to electromagnetic energy. This is in addition to any restoration processes that may occur subsequent to a damaging thermal insult from high-level electromagnetic energy exposure. Also significant is that the increased cell proliferation persists after the radiation stimulus is removed.

Cleary tells us:

> ***Persistent indications that the mammalian central nervous system is perhaps the most sensitive tissue for RF-induced alterations has provided the rationale for in vitro studies of effects on brain tissue and brain and neural cells. Not surprisingly, in vitro brain cell sensitivities to RF exposure are among the highest reported.***[93]

At the same time, the U.S. Environmental Protection Agency released a draft copy of its report on the evaluation of the potential carcinogenicity of electromagnetic fields. The report, first of all, finds that

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[92] *S. F. Cleary, et al., "Glioma Proliferation Modulated in Vitro by Isothermal Radiofrequency Radiation Exposure," Radiation Research 121, (1990) pp. 38-45.*

[93] *S. F. Cleary, Biological Effects and Medical Applications of Electromagnetic Energy, ed. O. P. Gandhi (1990), p. 348.*

In view of these laboratory studies, there is reason to believe that the findings of carcinogenicity in humans are biologically plausible.[94]

Of course, they were referring to laboratory studies that they had reviewed. This admission by the EPA means that the carcinogenic effects of electromagnetic energy are valid or likely.

The report continues with a reasonable clarification about the energy stored in the near-zone of transmitting antennas:

A dielectric or conductive object placed in the field will absorb more power (energy/time) than is predicted to be incident on the object by the power density calculation.

As has been described, some stored energy is also absorbed into the head and brain of a portable phone user. Industry researchers and spokesmen often claim that the stored energy collapses back into the antenna and is restored twice each cycle. That physical action has already been addressed with the explanation of how the energy is stored in the fields around the antenna and how some of that energy is drawn into the head of a nearby operator. The EPA, confirmed exactly the same phenomenon by reporting:

In such cases, the object is absorbing stored energy from the electric field as the movement of charged particles or polarization of the dielectric produces thermal motion . . . (see footnote 94).

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[94] *U.S. Environmental Protection Agency, Office of Research and Development, EPA 600 6-90 005B, October 1990.*

The EPA researchers were describing an actual physical mechanism that takes place in the biological tissue when A radiofrequency energy is absorbed. That is, it is converted into heat by causing molecules, electrons, and ions in the tissue to move. For an operator of a portable cellular telephone much of that motion is within the brain. The operator's brain cells are excited into motion to change the radiofrequency energy into heat energy.
The EPA continues:

> ***The body may be thought of as an antenna that absorbs energy from the field . . . (see footnote 94).***

Although the analogy is somewhat removed from what is actually happening, it does point out that the EPA acknowledges that both radiated and stored energy are absorbed by biological tissue in close proximity to a radiation source.

On a smaller scale, the EPA acknowledges that microscopic interactions occur at the level of individual cells and at cell membranes and are observed to have effects on the motion of ions.

Although the precise mechanism of interaction that leads to adverse biological effects, such as cancer, was not yet known in 1990, some of the possibilities the EPA has listed include electrical current in the body and electromagnetic fields in "critical organs such as the brain." A comment related to the lack of knowledge of the specific damaging mechanism clarifies that the EPA is also lost in the investigation for a single specific causal connection. It would seem to be a questionable approach when dealing with a technology that has been shown over a period of thirty or more years to be harmful if applied improperly.